PATENT ABSTRACTS OF JAPAN

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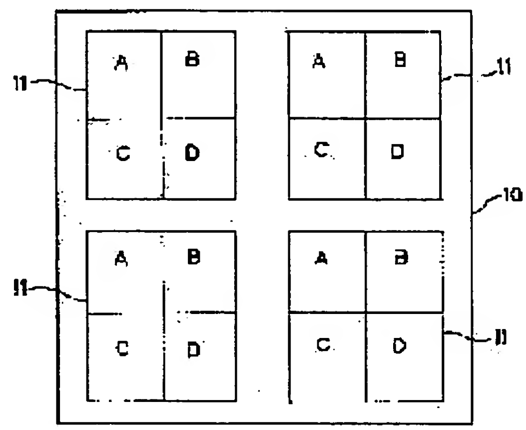
(54) LAP INSPECTING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To make it possible to shorten time required for measuring once and to perform measurement of a sufficient number of measuring points, by performing measurement at measuring points capable of calculating an error component originating on a board side, and performing measurement at measuring points capable of calculating an error component originating in a mask or reticle projection optical system side.
SOLUTION: Developed boards 10 are lapped up at every lot and are carried into a lap inspecting apparatus, and lap measurement is performed. After the finish of this lap measurement, the precision of lapping being a measured result is measured accurately and the precision of lapping is corrected. As an inspection in this first stage, correction values of the boards 10 are calculated at specified measuring points. Next, at measuring points for measurement in the second stage, measurement is performed for the purpose of correction on the side of a reticle lens. Namely, a shot by the same reticle in a board 10 is only for panels 11, but a lap correction value on the reticle lens side at each shot is calculated by measuring points of at least four corners within that shot.



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CLAIMS

[Claim(s)]
[Claim 1] In the superposition inspection approach which measures the superposition condition of the pattern formed in the mask or the reticle pattern by the aligner which uses a projection optical system on a substrate and carries out projection exposure The phase which measures the measurement point which can compute the error component which originates said superposition measurement in said substrate side, The superposition inspection approach characterized by dividing into the phase which measures the measurement point which can compute the error component resulting from a said mask, or reticle and projection optical system side, and carrying out gradually.
[Claim 2] The superposition inspection approach according to claim 1 characterized by measuring the measurement point which computes correction value from the result of said superposition measurement, carries out alignment amendment to said aligner based on the correction value, forms a pattern with said aligner again, and can check the superposition condition of the pattern.
[Claim 3] The superposition inspection approach according to claim 1 or 2 characterized by controlling on-line the processing which performs said superposition measurement, computes correction value from the result of superposition measurement to a system equipped with said aligner, a resist coater and a developer, and a superposition metering device, and carries out alignment amendment to an aligner based on the correction value.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In case this invention relates to the superposition inspection approach of inspecting the superposition condition of an aligner, especially performs the lithography process in manufacture of a liquid crystal display device with in-line one, it relates to the suitable superposition inspection approach.
[0002]
[Description of the Prior Art] In recent years, at a lithography process, the precision of superposition required of an aligner with the detailed-izing is becoming severe. In the aligner for liquid crystal glass substrates especially exposed by dividing one substrate, it is also required to double the knot between adjoining shots, and superposition precision is important.
[0003] Moreover, at the lithography process of these days, in order to raise the yield, two or more sets of aligners, superposition test equipment and a resist coater, a developer, membrane formation equipment, an etching system, etc. were connected with one, and the in-line configuration which carries out automatic conveyance of the substrate (sample) is taken in many cases. In such an in-line configuration, it is required to manage the tact time of each equipment uniformly and to pour a substrate smoothly one after another to the equipment of degree process.
[0004] In superposition inspection of an aligner, a superposition condition is measured for the substrate suitably sampled from the exposed substrate with test equipment in a tentative way, and the method of feeding back the result to an aligner side as correction value of superposition, and maintaining superposition precision is learned. If it was in the former at that time, a thing called an in-line baton was not taken into consideration, namely, it was measuring by disregarding measurement time amount and putting in block all the measurement points that can compute superposition correction value to accuracy. Or in order to conduct inspection for improving superposition precision again, without delaying a line baton within in-line one, the measurement point size was reduced, and in order to perform proper amendment, it was measuring with the point size which cannot necessarily be referred to as enough.
[0005]
[Problem(s) to be Solved by the Invention] However, by the approach of measuring by putting in block all the measurement points that can compute superposition correction value to accuracy as mentioned above, measurement time amount will be taken, superposition inspection will become the cause of delaying a line baton, and the productivity of a line will fall. By the approach of on the other hand reducing a measurement point size simply, although what is necessary is just to become, in order [which is for calculating a check and correction value of superposition precision in simple] to perform more exact amendment, it is inadequate, and superposition precision cannot be driven into accuracy.
[0006] This invention was made in consideration of the trouble of the above-mentioned conventional technique, and can shorten 1 time of measurement time amount, and moreover, it aims at offering the superposition inspection approach which can measure sufficient measurement point size in order to amend superposition precision to accuracy.

[0007]
[Means for Solving the Problem] In order to attain the above-mentioned object, this invention is the superposition inspection approach which measures the superposition condition of the pattern formed in the mask or the reticle pattern by the aligner which uses a projection optical system on a substrate and carries out projection exposure. It divides into the phase which measures the measurement point which can compute the error component resulting from a phase [which measures the measurement point which can compute the error component which originates said superposition measurement in said substrate side], and said mask, or reticle and projection optical system side, and is made to carry out gradually.
[0008] Thus, since it divides into the measurement for detecting the superposition precision by the side of the measurement for detecting the superposition precision by the side of a substrate for superposition measurement, a mask, or reticle and a projection optical system and is measuring, 1 time of a measurement point size decreases, and measurement time amount is shortened. And since the proper superposition condition by the side of a substrate side and a mask, or reticle and a projection optical system is measured gradually, an exact superposition precision can be computed and superposition precision can be driven in.
[0009] Moreover, this invention is the superposition inspection approach which measures the measurement point which computes correction value from the result of the above-mentioned superposition measurement, carries out alignment amendment to said aligner based on the correction value, forms a pattern with said aligner again, and can check the superposition condition of the pattern.
[0010] Since alignment amendment of an aligner is performed based on the exact correction value computed from gradual superposition measurement and superposition precision of an aligner is driven in, the simple measurement of extent which can check a superposition condition is sufficient for subsequent superposition measurement, and it can reduce an inspection process.

[0011] Furthermore, this invention is the superposition inspection approach that the processing which performs the above-mentioned gradual superposition measurement, computes correction value from the result of superposition measurement to a system equipped with an aligner, a resist coater and a developer, and a superposition metering device, and carries out alignment amendment to an aligner based on the correction value is controlled on-line.
[0012] In order to be able to inspect the superposition precision of an aligner on real time since the system is connected on-line, and to drive into a desired superposition precision, it can perform promptly what kind of amendment must be carried out automatically, checking superposition precision. Moreover, if it is able to drive into a desired superposition precision, it is also possible to end and shorten measurement of a complicated superposition precision in the phase.
[0013]
[Embodiment of the Invention] A drawing is used for below and the operation gestalt of this invention is explained to it.
[0014] Drawing 2 shows the configuration of the lithography information management system which performed in-line-ization of an exposure process. In order to communicate the exposure machine (aligner), the coating machine (resist coater), developer (developer), and superposition measuring instrument (metering device) of two or more sets of liquid crystal substrates in a network, a host computer is used and it connects. Furthermore, the machine controller MC of dedication is formed between the host computer which carries out generalization control of the system, and each exposure unit (line which makes a lot a coating machine, an exposure machine, and a developer), and it enables it to collect the information on each equipment of an exposure machine, a coating machine, and a developer.
[0015] Next, the usual flow of the exposure process of a liquid crystal plate substrate is explained. First, the plate for one lot by which resist spreading was carried out in the coating machine (usually 10-30 sheets) is conveyed by the exposure machine, and the plates of all one lots are exposed with an exposure machine. After exposure is completed, the plate for the one lot is conveyed promptly to a developer, and development is performed. In the layer especially

whose precision of superposition is not severe, the plate for one lot which development ended is promptly moved to an etching process, and flows to the exposure process of the following layer.
[0016] However, in the layer which must manage superposition precision severely, a plate will be moved to a superposition measuring instrument for every lot after development, and superposition measurement will be performed there. After superposition measurement termination, if the superposition precision which it is as a result of measurement has satisfied specification, as mentioned above, it will be moved to the etching process and degree layer. However, the cause must be studied when heavy precision has not satisfied specification.
[0017] When the cause of not satisfying superposition precision here suits an exposure machine, it can be coped with by inputting the correction value of superposition into an exposure machine. The correction value of superposition should just perform superposition measurement to the measurement point which is computed from the measurement result by the superposition measuring instrument, and can compute the correction value of an exposure machine therefore. By the way, he adjusts the processing time of each equipment to some extent, and, usually is trying to raise the baton as a line in in-line one which consisted of drawing 2 as much as possible. for example, since processing of the equipment of order is completed before the processing time per one lot of a coating machine or a developer is alike positively from the processing time of an exposure machine, and processing of an exposure machine is completed, when early, the loss as a line baton will occur there. It must be made for the measurement time amount per one lot in a superposition measuring instrument to have to balance the line baton similarly. It depends for the measurement time amount of a superposition measuring instrument on the measurement point size or measurement plate number of sheets of superposition.
[0018] Now, usually in the stepper for liquid crystal, a screen is divided from a limit of an exposure field or plate size. Moreover, since productivity is raised, two or more panels may be exposed per plate. Beveling of the panel per such a plate and the example of division are shown in drawing 3 (in the example of a graphic display, the 4th page was picked in the panel 11 on one plate 10, and each panel 11 was quadrisected.). Moreover, A, B, C, and D show each pattern of division exposure among drawing. By the panel manufacturer, the number of panels exposed on one plate with the exposure machine for liquid crystal for a productivity drive has been increasing these days. Furthermore, it is better to lessen an exposure shots per hour as much as possible in a stepper for the improvement in a throughput. Exposing at the biggest possible shot using the reticle of two or more sheets, and creating many panels from one plate by the stepper, for these reasons, is performed. Based on these things, the inspection approach of this operation gestalt is described hereafter.
[0019] In the exposure machine for liquid crystal, in order to improve superposition precision, the various correction value of superposition is computed and it is possible to input the correction value into an equipment side. With this operation gestalt, the stepper mainly used as an exposure machine for liquid crystal is explained to an example, it roughly divides into the above-mentioned correction value, and reticle offset and plate offset exist in it. There are a reticle shift (x y), reticle rotation, and a scale factor in reticle offset (offset of a lens system is also included), and there are a plate shift (x y), plate rotation, a scaling (x y), and array perpendicularity of a stage in plate offset. Now, as the optimal superposition measurement point to the division and beveling on a plate like drawing 3 , it is desirable as an example to take the measurement point (for it to display by notation x among drawing) like drawing 4 . If superposition is measured like this drawing 4 , it is enough for correction value calculation of the reticle described in the top, and a plate.
[0020] By the way, although the superposition of four corners (they are two places in the one side) of one shot is measured in drawing 4 , this is the minimum requirement, and if it measures one side three or more points to one shot, it can compute still more accurate superposition correction value. Moreover, although it is the measurement number of sheets of a plate which performs superposition measurement, the more there is also much this, the measurement error of a measuring instrument will be reduced and, the more can compute accurate superposition correction value. However, the process of the photolithography of these days consists of in-line one in many cases, and in order to manage the baton of the whole line, the measurement time

amount and the plate number of sheets to measure in a superposition measuring instrument are limited to some extent, as mentioned above.
[0021] Then, in case the correction value of superposition is inputted into an exposure machine, the precision of the correction value by the approach computed from the measurement point of drawing 4 and this level explains the approach of this operation gestalt of calculating gradually the correction value of the reticle (mask) which can amend superposition, and a plate (substrate), according to the flow chart of drawing 1 .
[0022] The plate after the development was carried out by the developer is carried in to superposition test equipment for every lot, and superposition measurement is performed (step 1). Measurement here is easy to be the simple thing which is extent which can check superposition precision. It is distinguished after superposition measurement termination whether the superposition precision which it is as a result of measurement fulfills a predetermined precision (step 2). If it is filling, a superposition inspection process will be ended (step 8) and it will move to the following process. On the other hand, when superposition precision is not fulfilled, it progresses to the inspection process (step 3 or subsequent ones) which measures superposition precision to accuracy and amends superposition precision.
[0023] As the 1st-step inspection (step 3), the correction value of a plate is first computed on the measurement point like drawing 5 R> 5. If two or more plates are measured on the above-mentioned measurement point, precision will go up. In this case, it is important to measure in as long a pattern as possible, when measuring two or more shots of the same reticle within that each measurement point is the core of a shot, to measure the core in all reticles, and one more plate. If superposition is measured like drawing 5 at the core of each shot, the error component generated from factors, such as effect of lens distortion, and reticle rotation, a scale factor, is stopped, and the value near the correction value only by the side of a plate can be computed (step 31). By this approach, the correction value of the perpendicularity of the stage in which a plate shift (x y), plate rotation, a plate scaling (x y), and a plate are laid is calculated. When it is distinguished whether these correction value is below in a predetermined allowed value, or a predetermined superposition precision is satisfied (step 32) and it is satisfied, an inspection process is ended (step 8), and when not satisfied, based on the computed correction value (plate component), alignment amendment by the side of the plate of an exposure machine is performed (step 4). In addition, in drawing 5 , although superposition measurement is performed to all the shot cores of the quadrisection in the panel 11 of the 4th page in a plate 10, when also saying this that there are too many measure points due to a line baton, although measurement precision falls, the superposition measurement point size of the same shot may be reduced.
[0024] Next, although it shifts to the 2nd-step inspection (step 5), it is desirable to perform the 2nd-step superposition amendment in the condition of the error component by the side of a plate having been stabilized by alignment amendment (step 4) of superposition performed after the 1st-step inspection before that, and having removed.
[0025] The example of the measurement point of the 2nd-step measurement (step 51) is shown in drawing 6 . Here, it aims at performing amendment by the side of a reticle lens. The measurement point of drawing 6 is for computing the reticle of the superposition correction value of an exposure machine, a lens component, and the residual component of a plate. Although the shot by the same reticle in one plate 10 is only a part for one panel (panel 11 at the upper left of drawing), the measurement point in the shot is made into at least 4 corners. Of course, if allowances are in measurement time amount, although you may carry out, not only in four corners but in each side in one shot, the main points will be an increase of a measurement point size, and measuring between the measure points in one shot by the biggest possible span further. The correction value of the superposition by the side of the reticle lens in each shot is computable with measurement of the four above-mentioned corner. Next, when it is distinguished whether the computed correction value has satisfied a predetermined superposition precision (step 52) and it is satisfied, an inspection process is ended (step 8), and when not satisfied, based on the computed correction value (offset), alignment amendment by the side of the reticle lens of an exposure machine is performed (step 6). This alignment amendment can amend a stepper's reticle shift (x y), reticle rotation, and a scale factor.

[0026] Furthermore, although the superposition of the core of Shot A is measured in drawing 6 , this is for amending further residue of the plate component which amended in the inspection process of the 1st step. Even if it performs superposition amendment of an overall plate component in the 1st step, it is because an error cannot be driven into zero in each points of all and reticle offset will also change in connection with it, if the variation for every plate is taken into consideration. If the plate which performs superposition measurement on the point like drawing 6 is measured in two or more sheets, the precision of superposition amendment can be raised further. On the other hand, when saying that there are many point sizes also on the measurement point of drawing 6 due to a line baton, there is also a method of reducing the measurement point size of the core of a certain shot (here A shots).
[0027] As the 3rd-step inspection (step 7), the measurement point like drawing 7 performs superposition measurement, and it acts as the monitor of the condition of equipment. In addition, it assumes that it was stabilized in the layer which is going to drive in superposition precision in the above 1st and the 2nd step, and superposition precision was able to be driven in.
[0028] Two or more panels 11 are measured at the same shot in a plate 10 (here A shots) like drawing 7 (step 71). Under the present circumstances, the measurement point per shot shall measure four corners and one core at worst. Here, it is desirable like the view of the 1st and the 2nd-step measurement point to measure two or more points by the longest possible span. That is, if it is measurement about A shots for a certain panel, the measurement point of four corners in the A shots will be measured by as long the span as possible. Moreover, although the main measurement point measures each core of A shots of a different panel, the span between the panel is desirable [the longer possible one].
[0029] Thus, if the measurement point like drawing 7 performs superposition measurement for every lot and every period of a certain, although definition is carried out to specific reticle, in the viewpoint of superposition, the condition of equipment can be known in simple. In step 72, if superposition precision is good, it will end (step 8) and a superposition inspection process will still be again returned to the inspection process of the 1st step of step 3 at the time of a defect.

[0030] As mentioned above, although how to perform superposition amendment gradually has been described when there is a limit which is in a superposition measurement point size due to an in-line baton, with this operation gestalt, it can set up freely in all the 1st, 2nd, and 3rd phase also not only in a measurement point size but in the plate number of sheets to measure. What is necessary is just to determine in setting out from the superposition measurement point size and the measurement precision needed per one plate of an in-line baton and each phase.
[0031] In addition, with this operation gestalt, although the example of panel 4 beveling and 1 panel quadrisection was described in one plate, this invention is limited to neither the number of these beveling, nor the number of partitions. For example, more exact superposition amendment by amending gradually [when a superposition measurement point size has a limit whether it is except 4 beveling or the number of partitions in 1 panel is except quadrisection and] the number of panels which can be taken from one plate can be performed, without delaying a line baton. Furthermore, with this operation gestalt, although the approach about a stepper has been described as an exposure machine, this invention can be adapted about any exposure machines used not only in this but in a line.
[0032]
[Effect of the Invention] Since it divides into the measurement for detecting the superposition precision by the side of the measurement for detecting the superposition precision by the side of a substrate for superposition measurement, a mask, or reticle and a projection optical system and is inspecting gradually according to this invention as mentioned above, 1 time of a measurement point size decreases, and measurement time amount can be shortened. And since a superposition condition is gradually measured to the proper measurement point which can compute the error component by the side of a substrate side and a mask, or reticle and a projection optical system, an exact superposition precision can be computed and superposition precision can be driven in certainly. Therefore, if it applies to the photolithography process which consists of in-line one, the superposition precision of an aligner can be driven into accuracy,

without delaying the whole line baton.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] In case this invention relates to the superposition inspection approach of inspecting the superposition condition of an aligner, especially performs the lithography process in manufacture of a liquid crystal display device with in-line one, it relates to the suitable superposition inspection approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, at a lithography process, the precision of superposition required of an aligner with the detailed-izing is becoming severe. In the aligner for liquid crystal glass substrates especially exposed by dividing one substrate, it is also required to double the knot between adjoining shots, and superposition precision is important.
[0003] Moreover, at the lithography process of these days, in order to raise the yield, two or more sets of aligners, superposition test equipment and a resist coater, a developer, membrane formation equipment, an etching system, etc. were connected with one, and the in-line configuration which carries out automatic conveyance of the substrate (sample) is taken in many cases. In such an in-line configuration, it is required to manage the tact time of each equipment uniformly and to pour a substrate smoothly one after another to the equipment of degree process.
[0004] In superposition inspection of an aligner, a superposition condition is measured for the substrate suitably sampled from the exposed substrate with test equipment in a tentative way, and the method of feeding back the result to an aligner side as correction value of superposition, and maintaining superposition precision is learned. If it was in the former at that time, a thing called an in-line baton was not taken into consideration, namely, it was measuring by disregarding measurement time amount and putting in block all the measurement points that can compute superposition correction value to accuracy. Or in order to conduct inspection for improving superposition precision again, without delaying a line baton within in-line one, the measurement point size was reduced, and in order to perform proper amendment, it was measuring with the point size which cannot necessarily be referred to as enough.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since it divides into the measurement for detecting the superposition precision by the side of the measurement for detecting the superposition precision by the side of a substrate for superposition measurement, a mask, or reticle and a projection optical system and is inspecting gradually according to this invention as mentioned above, 1 time of a measurement point size decreases, and measurement time amount can be shortened. And since a superposition condition is gradually measured to the proper measurement point which can compute the error component by the side of a substrate side and a mask, or reticle and a projection optical system, an exact superposition precision can be computed and superposition precision can be driven in certainly. Therefore, if it applies to the photolithography process which consists of in-line one, the superposition precision of an aligner can be driven into accuracy, without delaying the whole line baton.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, by the approach of measuring by putting in block all the measurement points that can compute superposition correction value to accuracy as mentioned above, measurement time amount will be taken, superposition inspection will become the cause of delaying a line baton, and the productivity of a line will fall. By the approach of on the other hand reducing a measurement point size simply, although what is necessary is just to become, in order [which is for calculating a check and correction value of superposition precision in simple] to perform more exact amendment, it is inadequate, and superposition precision cannot be driven into accuracy.
[0006] This invention was made in consideration of the trouble of the above-mentioned conventional technique, and can shorten 1 time of measurement time amount, and moreover, it aims at offering the superposition inspection approach which can measure sufficient measurement point size in order to amend superposition precision to accuracy.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned object, this invention is the superposition inspection approach which measures the superposition condition of the pattern formed in the mask or the reticle pattern by the aligner which uses a projection optical system on a substrate and carries out projection exposure. It divides into the phase which measures the measurement point which can compute the error component resulting from a phase [which measures the measurement point which can compute the error component which originates said superposition measurement in said substrate side], and said mask, or reticle and projection optical system side, and is made to carry out gradually.
[0008] Thus, since it divides into the measurement for detecting the superposition precision by the side of the measurement for detecting the superposition precision by the side of a substrate for superposition measurement, a mask, or reticle and a projection optical system and is measuring, 1 time of a measurement point size decreases, and measurement time amount is shortened. And since the proper superposition condition by the side of a substrate side and a mask, or reticle and a projection optical system is measured gradually, an exact superposition precision can be computed and superposition precision can be driven in.
[0009] Moreover, this invention is the superposition inspection approach which measures the measurement point which computes correction value from the result of the above-mentioned superposition measurement, carries out alignment amendment to said aligner based on the correction value, forms a pattern with said aligner again, and can check the superposition condition of the pattern.
[0010] Since alignment amendment of an aligner is performed based on the exact correction value computed from gradual superposition measurement and superposition precision of an aligner is driven in, the simple measurement of extent which can check a superposition condition is sufficient for subsequent superposition measurement, and it can reduce an inspection process.

[0011] Furthermore, this invention is the superposition inspection approach that the processing which performs the above-mentioned gradual superposition measurement, computes correction value from the result of superposition measurement to a system equipped with an aligner, a resist coater and a developer, and a superposition metering device, and carries out alignment amendment to an aligner based on the correction value is controlled on-line.
[0012] In order to be able to inspect the superposition precision of an aligner on real time since the system is connected on-line, and to drive into a desired superposition precision, it can perform promptly what kind of amendment must be carried out automatically, checking superposition precision. Moreover, if it is able to drive into a desired superposition precision, it is also possible to end and shorten measurement of a complicated superposition precision in the phase.
[0013]
[Embodiment of the Invention] A drawing is used for below and the operation gestalt of this invention is explained to it.
[0014] Drawing 2 shows the configuration of the lithography information management system which performed in-line-ization of an exposure process. In order to communicate the exposure

machine (aligner), the coating machine (resist coater), developer (developer), and superposition measuring instrument (metering device) of two or more sets of liquid crystal substrates in a network, a host computer is used and it connects. Furthermore, the machine controller MC of dedication is formed between the host computer which carries out generalization control of the system, and each exposure unit (line which makes a lot a coating machine, an exposure machine, and a developer), and it enables it to collect the information on each equipment of an exposure machine, a coating machine, and a developer.

[0015] Next, the usual flow of the exposure process of a liquid crystal plate substrate is explained. First, the plate for one lot by which resist spreading was carried out in the coating machine (usually 10-30 sheets) is conveyed by the exposure machine, and the plates of all one lots are exposed with an exposure machine. After exposure is completed, the plate for the one lot is conveyed promptly to a developer, and development is performed. In the layer especially whose precision of superposition is not severe, the plate for one lot which development ended is promptly moved to an etching process, and flows to the exposure process of the following layer.

[0016] However, in the layer which must manage superposition precision severely, a plate will be moved to a superposition measuring instrument for every lot after development, and superposition measurement will be performed there. After superposition measurement termination, if the superposition precision which it is as a result of measurement has satisfied specification, as mentioned above, it will be moved to the etching process and degree layer. However, the cause must be studied when heavy precision has not satisfied specification.

[0017] When the cause of not satisfying superposition precision here suits an exposure machine, it can be coped with by inputting the correction value of superposition into an exposure machine. The correction value of superposition should just perform superposition measurement to the measurement point which is computed from the measurement result by the superposition measuring instrument, and can compute the correction value of an exposure machine therefore. By the way, he adjusts the processing time of each equipment to some extent, and, usually is trying to raise the baton as a line in in-line one which consisted of drawing 2 as much as possible. for example, since processing of the equipment of order is completed before the processing time per one lot of a coating machine or a developer is alike positively from the processing time of an exposure machine, and processing of an exposure machine is completed, when early, the loss as a line baton will occur there. It must be made for the measurement time amount per one lot in a superposition measuring instrument to have to balance the line baton similarly. It depends for the measurement time amount of a superposition measuring instrument on the measurement point size or measurement plate number of sheets of superposition.

[0018] Now, usually in the stepper for liquid crystal, a screen is divided from a limit of an exposure field or plate size. Moreover, since productivity is raised, two or more panels may be exposed per plate. Beveling of the panel per such a plate and the example of division are shown in drawing 3 (in the example of a graphic display, the 4th page was picked in the panel 11 on one plate 10, and each panel 11 was quadrisected.). Moreover, A, B, C, and D show each pattern of division exposure among drawing. By the panel manufacturer, the number of panels exposed on one plate with the exposure machine for liquid crystal for a productivity drive has been increasing these days. Furthermore, it is better to lessen an exposure shots per hour as much as possible in a stepper for the improvement in a throughput. Exposing at the biggest possible shot using the reticle of two or more sheets, and creating many panels from one plate by the stepper, for these reasons, is performed. Based on these things, the inspection approach of this operation gestalt is described hereafter.

[0019] In the exposure machine for liquid crystal, in order to improve superposition precision, the various correction value of superposition is computed and it is possible to input the correction value into an equipment side. With this operation gestalt, the stepper mainly used as an exposure machine for liquid crystal is explained to an example, it roughly divides into the above-mentioned correction value, and reticle offset and plate offset exist in it. There are a reticle shift (x y), reticle rotation, and a scale factor in reticle offset (offset of a lens system is also included), and there are a plate shift (x y), plate rotation, a scaling (x y), and array perpendicularity of a stage in plate offset. Now, as the optimal superposition measurement point to the division and beveling on

a plate like drawing 3 , it is desirable as an example to take the measurement point (for it to display by notation x among drawing) like drawing 4 . If superposition is measured like this drawing 4 , it is enough for correction value calculation of the reticle described in the top, and a plate.

[0020] By the way, although the superposition of four corners (they are two places in the one side) of one shot is measured in drawing 4 , this is the minimum requirement, and if it measures one side three or more points to one shot, it can compute still more accurate superposition correction value. Moreover, although it is the measurement number of sheets of a plate which performs superposition measurement, the more there is also much this, the measurement error of a measuring instrument will be reduced and, the more can compute accurate superposition correction value. However, the process of the photolithography of these days consists of in-line one in many cases, and in order to manage the baton of the whole line, the measurement time amount and the plate number of sheets to measure in a superposition measuring instrument are limited to some extent, as mentioned above.

[0021] Then, in case the correction value of superposition is inputted into an exposure machine, the precision of the correction value by the approach computed from the measurement point of drawing 4 and this level explains the approach of this operation gestalt of calculating gradually the correction value of the reticle (mask) which can amend superposition, and a plate (substrate), according to the flow chart of drawing 1 .

[0022] The plate after the development was carried out by the developer is carried in to superposition test equipment for every lot, and superposition measurement is performed (step 1). Measurement here is easy to be the simple thing which is extent which can check superposition precision. It is distinguished after superposition measurement termination whether the superposition precision which it is as a result of measurement fulfills a predetermined precision (step 2). If it is filling, a superposition inspection process will be ended (step 8) and it will move to the following process. On the other hand, when superposition precision is not fulfilled, it progresses to the inspection process (step 3 or subsequent ones) which measures superposition precision to accuracy and amends superposition precision.

[0023] As the 1st-step inspection (step 3), the correction value of a plate is first computed on the measurement point like drawing 5 R> 5. If two or more plates are measured on the above-mentioned measurement point, precision will go up. In this case, it is important to measure in as long a pattern as possible, when measuring two or more shots of the same reticle within that each measurement point is the core of a shot, to measure the core in all reticles, and one more plate. If superposition is measured like drawing 5 at the core of each shot, the error component generated from factors, such as effect of lens distortion, and reticle rotation, a scale factor, is stopped, and the value near the correction value only by the side of a plate can be computed (step 31). By this approach, the correction value of the perpendicularity of the stage in which a plate shift (x y), plate rotation, a plate scaling (x y), and a plate are laid is calculated. When it is distinguished whether these correction value is below in a predetermined allowed value, or a predetermined superposition precision is satisfied (step 32) and it is satisfied, an inspection process is ended (step 8), and when not satisfied, based on the computed correction value (plate component), alignment amendment by the side of the plate of an exposure machine is performed (step 4). In addition, in drawing 5 , although superposition measurement is performed to all the shot cores of the quadrisection in the panel 11 of the 4th page in a plate 10, when also saying this that there are too many measure points due to a line baton, although measurement precision falls, the superposition measurement point size of the same shot may be reduced.

[0024] Next, although it shifts to the 2nd-step inspection (step 5), it is desirable to perform the 2nd-step superposition amendment in the condition of the error component by the side of a plate having been stabilized by alignment amendment (step 4) of superposition performed after the 1st-step inspection before that, and having removed.

[0025] The example of the measurement point of the 2nd-step measurement (step 51) is shown in drawing 6 . Here, it aims at performing amendment by the side of a reticle lens. The measurement point of drawing 6 is for computing the reticle of the superposition correction value of an exposure machine, a lens component, and the residual component of a plate.

Although the shot by the same reticle in one plate 10 is only a part for one panel (panel 11 at the upper left of drawing), the measurement point in the shot is made into at least 4 corners. Of course, if allowances are in measurement time amount, although you may carry out, not only in four corners but in each side in one shot, the main points will be an increase of a measurement point size, and measuring between the measure points in one shot by the biggest possible span further. The correction value of the superposition by the side of the reticle lens in each shot is computable with measurement of the four above-mentioned corner. Next, when it is distinguished whether the computed correction value has satisfied a predetermined superposition precision (step 52) and it is satisfied, an inspection process is ended (step 8), and when not satisfied, based on the computed correction value (offset), alignment amendment by the side of the reticle lens of an exposure machine is performed (step 6). This alignment amendment can amend a stepper's reticle shift (x y), reticle rotation, and a scale factor.
[0026] Furthermore, although the superposition of the core of Shot A is measured in drawing 6 , this is for amending further residue of the plate component which amended in the inspection process of the 1st step. Even if it performs superposition amendment of an overall plate component in the 1st step, it is because an error cannot be driven into zero in each points of all and reticle offset will also change in connection with it, if the variation for every plate is taken into consideration. If the plate which performs superposition measurement on the point like drawing 6 is measured in two or more sheets, the precision of superposition amendment can be raised further. On the other hand, when saying that there are many point sizes also on the measurement point of drawing 6 due to a line baton, there is also a method of reducing the measurement point size of the core of a certain shot (here A shots).
[0027] As the 3rd-step inspection (step 7), the measurement point like drawing 7 performs superposition measurement, and it acts as the monitor of the condition of equipment. In addition, it assumes that it was stabilized in the layer which is going to drive in superposition precision in the above 1st and the 2nd step, and superposition precision was able to be driven in.
[0028] Two or more panels 11 are measured at the same shot in a plate 10 (here A shots) like drawing 7 (step 71). Under the present circumstances, the measurement point per shot shall measure four corners and one core at worst. Here, it is desirable like the view of the 1st and the 2nd-step measurement point to measure two or more points by the longest possible span. That is, if it is measurement about A shots for a certain panel, the measurement point of four corners in the A shots will be measured by as long the span as possible. Moreover, although the main measurement point measures each core of A shots of a different panel, the span between the panel is desirable [the longer possible one].
[0029] Thus, if the measurement point like drawing 7 performs superposition measurement for every lot and every period of a certain, although definition is carried out to specific reticle, in the viewpoint of superposition, the condition of equipment can be known in simple. In step 72, if superposition precision is good, it will end (step 8) and a superposition inspection process will still be again returned to the inspection process of the 1st step of step 3 at the time of a defect.

[0030] As mentioned above, although how to perform superposition amendment gradually has been described when there is a limit which is in a superposition measurement point size due to an in-line baton, with this operation gestalt, it can set up freely in all the 1st, 2nd, and 3rd phase also not only in a measurement point size but in the plate number of sheets to measure. What is necessary is just to determine in setting out from the superposition measurement point size and the measurement precision needed per one plate of an in-line baton and each phase.
[0031] In addition, with this operation gestalt, although the example of panel 4 beveling and 1 panel quadrisection was described in one plate, this invention is limited to neither the number of these beveling, nor the number of partitions. For example, more exact superposition amendment by amending gradually [when a superposition measurement point size has a limit whether it is except 4 beveling or the number of partitions in 1 panel is except quadrisection and] the number of panels which can be taken from one plate can be performed, without delaying a line baton. Furthermore, with this operation gestalt, although the approach about a stepper has been described as an exposure machine, this invention can be adapted about any exposure machines

used not only in this but in a line.

[Translation done.]

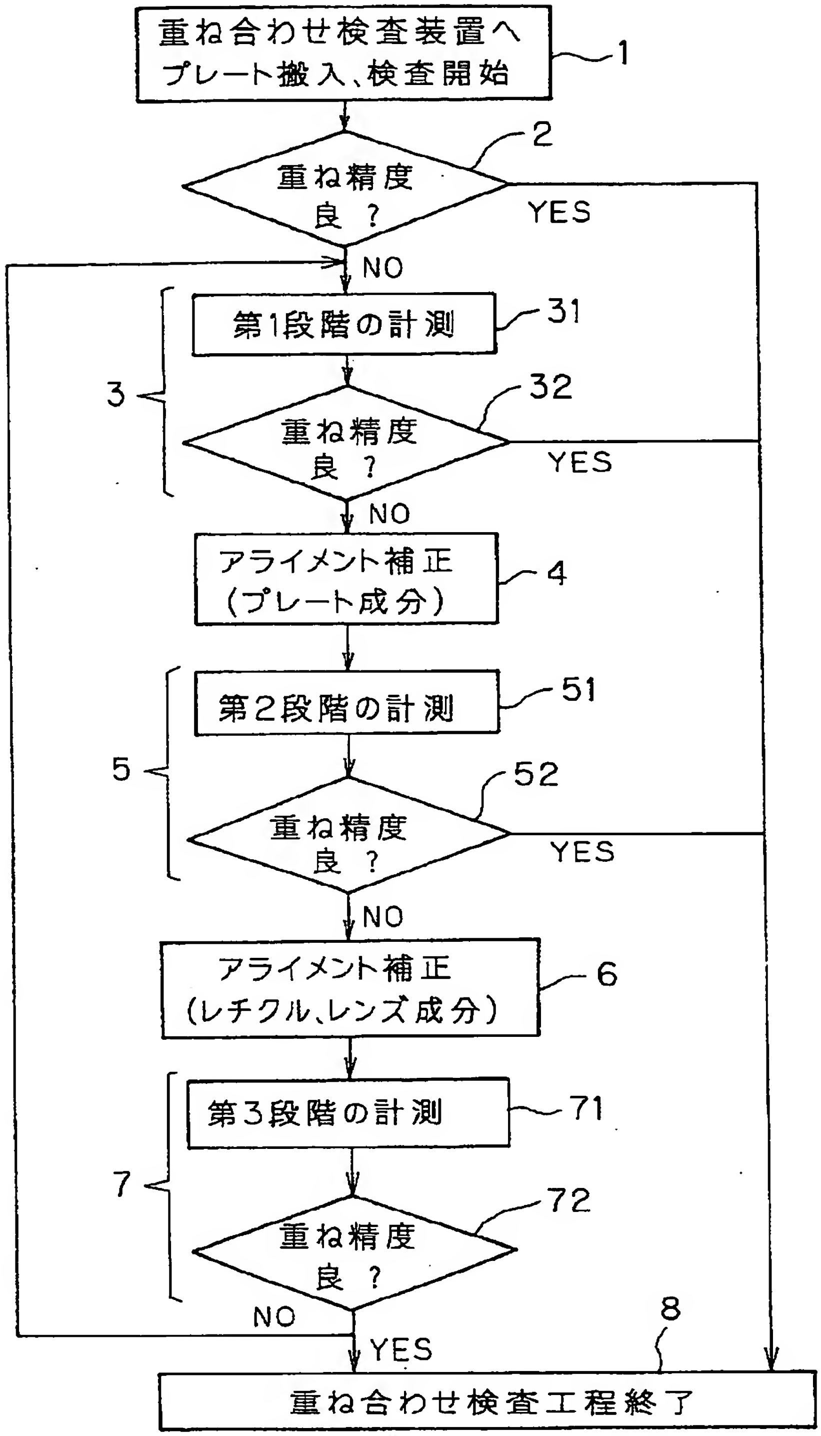
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the flow chart which shows 1 operation gestalt of the superposition inspection approach of this invention.
[Drawing 2] It is the block diagram which applies the superposition inspection approach of this invention and in which showing an example of the process control system of a photolithography process.
[Drawing 3] It is drawing showing beveling of the panel in 1 plate and the division of each panel which are exposed by the exposure machine in the operation gestalt of this invention.
[Drawing 4] It is drawing showing the example of the proper superposition measurement point performed to exposure of drawing 3 .
[Drawing 5] It is drawing in the operation gestalt of this invention showing the measurement point of the 1st-step superposition measurement.
[Drawing 6] It is drawing in the operation gestalt of this invention showing the measurement point of the 2nd-step superposition measurement.
[Drawing 7] It is drawing showing the measurement point of the 3rd-step superposition measurement for getting to know a superposition condition in the operation gestalt of this invention.
[Description of Notations]
10 Plate (Substrate)
11 Panel
MC Machine controller

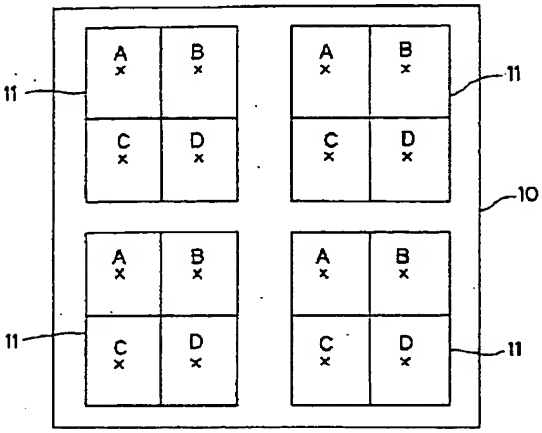
[Translation done.]

DRAWINGS

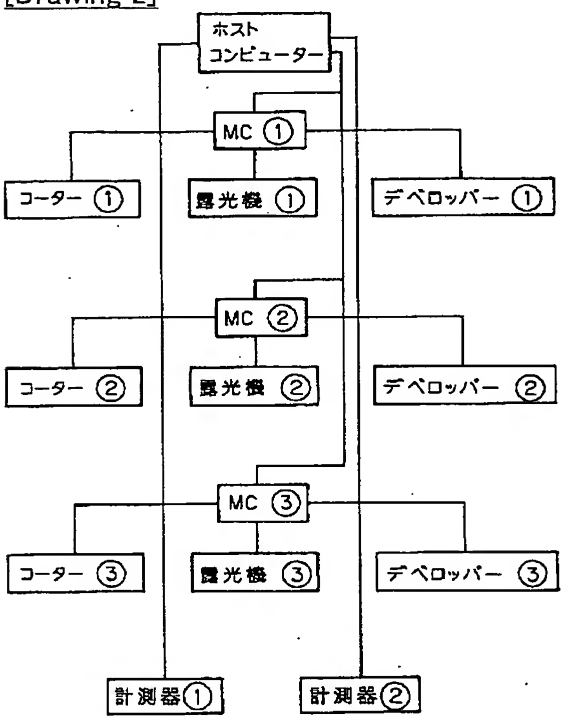
[Drawing 1]


重ね合わせ検査装置へ
プレート搬入、検査開始
1
2
重ね精度
良 ?
YES
NO
第1段階の計測
31
3
32
重ね精度
良 ?
YES
NO
アライメント補正
(プレート成分)
4
第2段階の計測
51
5
52
重ね精度
良 ?
YES
NO
アライメント補正
(レチクル、レンズ成分)
6
第3段階の計測
71
7
72
重ね精度
良 ?
NO
YES
8
重ね合わせ検査工程終了

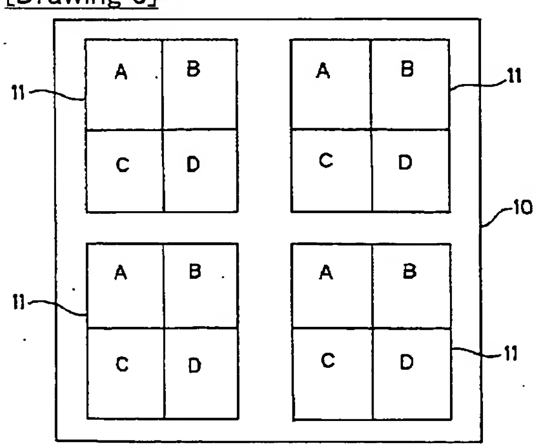
[Drawing 5]



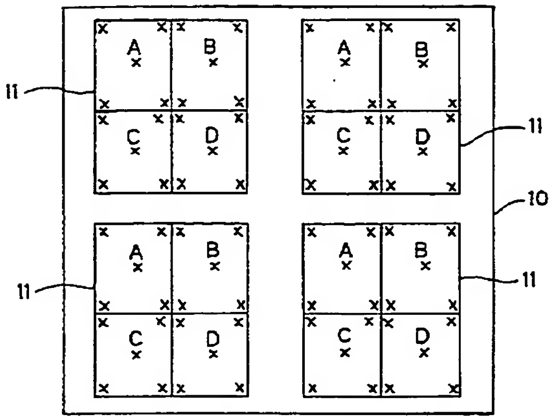
[Drawing 2]



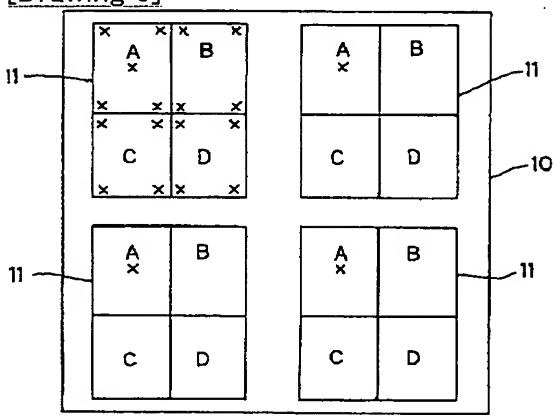
[Drawing 3]



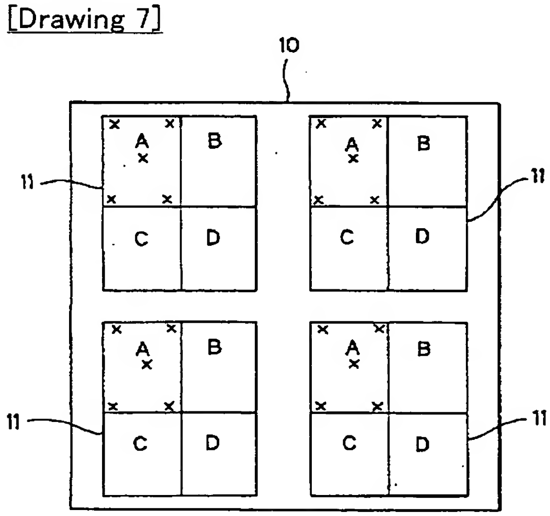
[Drawing 4]



[Drawing 6]



[Drawing 7]



[Translation done.]

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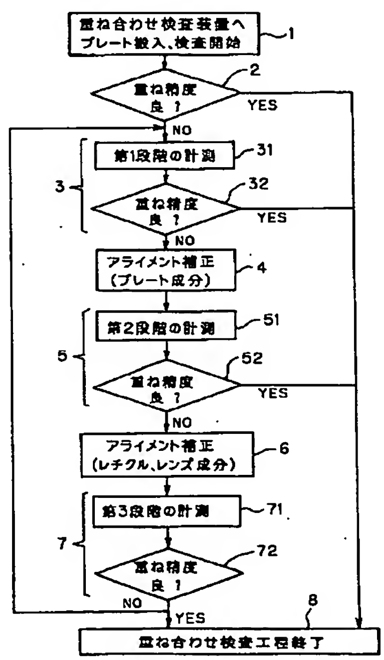
(54)【発明の名称】　重ね合わせ検査方法

(57)【要約】

【課題】　フォトリソグラフィー工程全体のラインタクトを遅らせることなく、露光装置の重ね合わせ精度を正確に追い込む。

【解決手段】　第１段階の検査工程では、検査装置に搬入された現像後のプレートに対し、露光装置のプレート側に起因する誤差成分を算出できる計測ポイントを計測して、プレート側の重ね合わせ精度の補正値（プレート成分）を算出し、算出された補正値に基づきプレート側のアライメント補正を行う。第２段階の検査工程では、マスク又はレチクル・レンズ側に起因する誤差成分を算出できる計測ポイントを計測し、マスク又はレチクル・レンズ側の重ね合わせ精度の補正値（マスク又はレチクル・レンズ成分）を算出し、この補正値に基づきマスク又はレチクル・レンズ側のアライメント補正を行う。こうして、重ね合わせ精度を段階的に追い込む。



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【特許請求の範囲】

【請求項１】　マスク又はレチクルパターンを基板上に投影光学系を用いて投影露光する露光装置により形成されたパターンの重ね合わせ状態を計測する重ね合わせ検査方法において、前記重ね合わせ計測を、前記基板側に起因する誤差成分を算出できる計測ポイントを計測する段階と、前記マスク又はレチクル・投影光学系側に起因する誤差成分を算出できる計測ポイントを計測する段階とに分けて、段階的に行うようにしたことを特徴とする重ね合わせ検査方法。

【請求項２】　前記重ね合わせ計測の結果から補正値を算出し、その補正値に基づいて前記露光装置に対してアライメント補正を実施し、再度、前記露光装置によりパターンを形成し、そのパターンの重ね合わせ状態を確認できる計測ポイントを計測することを特徴とする請求項１記載の重ね合わせ検査方法。

【請求項３】　前記露光装置と、レジスト塗布装置、現像装置及び重ね合わせ計測装置を備えるシステムに対して、前記重ね合わせ計測を行い、重ね合わせ計測の結果から補正値を算出し、その補正値に基づいて露光装置に対するアライメント補正を実施する処理がオンラインで制御されていることを特徴とする請求項１又は２記載の重ね合わせ検査方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は露光装置の重ね合わせ状態を検査する重ね合わせ検査方法に係り、特に液晶表示デバイスの製造におけるリソグラフィー工程をインラインで行う際に好適な重ね合わせ検査方法に関する。

【０００２】

【従来の技術】近年、リソグラフィー工程では、その微細化に伴って露光装置に要求される重ね合わせの精度が厳しくなってきている。殊に、一枚の基板を分割して露光を行う液晶ガラス基板用の露光装置においては、隣接するショット間のつなぎ目を合わせることも必要であり、重ね合わせ精度が重要である。

【０００３】また、昨今のリソグラフィー工程では、歩留まりをあげるために、複数台の露光装置や重ね合わせ検査装置およびレジスト塗布装置、現像装置、成膜装置、エッチング装置等を一本につないで、基板（試料）を自動搬送するインライン構成を取っている場合が多い。このようなインライン構成の場合、各装置のタクトタイムを一律に管理して、基板を次工程の装置へと次々とスムーズに流していくことが必要である。

【０００４】露光装置の重ね合わせ検査においては、露光した基板から適宜サンプリングした基板を試験的に検査装置で重ね合わせ状態を計測し、その結果を重ね合わせの補正値として露光装置側にフィードバックして重ね合わせ精度を維持する方法が知られている。その際、従来にあっては、インラインのタクトというものは考慮せず、即ち計測時間は無視して、重ね合わせ補正値を正確に算出できる計測ポイントを全て一括して計測を行っていた。あるいは、また、重ね合わせ精度を良くするための検査をインライン内でラインタクトを遅らせることなく行うために、計測ポイント数を減らし、適正な補正を行うために必ずしも十分とは言えないポイント数で計測を行っていた。

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【０００５】

【発明が解決しようとする課題】しかしながら、上記のように、重ね合わせ補正値を正確に算出できる計測ポイントを全て一括して計測を行う方法では、計測時間がかかり、重ね合わせ検査がラインタクトを遅らせる原因となり、ラインの生産性が低下してしまう。一方、単純に計測ポイント数を減らす方法では、簡易的に重ね合わせ精度の確認や補正値を求めるためであるならば良いが、より正確な補正を行うためには不十分であり、重ね合わせ精度を正確に追い込むことはできない。

【０００６】本発明は上記従来技術の問題点を考慮してなされたもので、一回の計測時間を短縮でき、しかも、重ね合わせ精度を正確に補正するために十分な計測ポイント数の計測を行える重ね合わせ検査方法を提供することを目的とする。

【０００７】

【課題を解決するための手段】上記目的を達成するために、本発明は、マスク又はレチクルパターンを基板上に投影光学系を用いて投影露光する露光装置により形成されたパターンの重ね合わせ状態を計測する重ね合わせ検査方法であって、前記重ね合わせ計測を、前記基板側に起因する誤差成分を算出できる計測ポイントを計測する段階と、前記マスク又はレチクル・投影光学系側に起因する誤差成分を算出できる計測ポイントを計測する段階とに分けて、段階的に行うようにしたものである。

【０００８】このように、重ね合わせ計測を、基板側の重ね合わせ精度を検出するための計測とマスク又はレチクル・投影光学系側の重ね合わせ精度を検出するための計測とに分けて計測しているため、一回の計測ポイント数が減少し、計測時間が短縮する。しかも、基板側及びマスク又はレチクル・投影光学系側の適正な重ね合わせ状態の計測を段階的に行うので、正確な重ね合わせ精度を算出でき、重ね合わせ精度を追い込むことができる。

【０００９】また、本発明は、上記重ね合わせ計測の結果から補正値を算出し、その補正値に基づいて前記露光装置にアライメント補正を実施し、再度、前記露光装置によりパターンを形成し、そのパターンの重ね合わせ状態を確認できる計測ポイントを計測する重ね合わせ検査方法である。

【００１０】段階的な重ね合わせ計測より算出された正確な補正値に基づいて露光装置のアライメント補正を行い、露光装置の重ね合わせ精度の追い込みを行っているため、その後の重ね合わせ計測は重ね合わせ状態を確認

できる程度の簡易的な計測で足り、検査工程を縮小できる。

【００１１】更に本発明は、露光装置と、レジスト塗布装置、現像装置及び重ね合わせ計測装置を備えるシステムに対して、上記の段階的な重ね合わせ計測を行い、重ね合わせ計測の結果から補正値を算出し、その補正値に基づいて露光装置に対するアライメント補正を実施する処理がオンラインで制御されている重ね合わせ検査方法である。

【００１２】システムをオンラインで接続しているため、露光装置の重ね合わせ精度をリアルタイムで検査でき、所望の重ね合わせ精度に追い込むために、どのような補正をしなければならないかを、重ね合わせ精度を確認しながら迅速に且つ自動で実行することができる。また、所望の重ね合わせ精度に追い込むことができたなら、その段階で煩雑な重ね合わせ精度の計測を終了したり、また短縮したりすることも可能である。

【００１３】

【発明の実施の形態】以下に本発明の実施形態を図面を用いて説明する。

【００１４】図２は露光工程のインライン化を行った、リソグラフィー情報管理システムの構成を示すものである。複数台の液晶基板の露光機（露光装置）、コーター（レジスト塗布装置）、デベロッパー（現像装置）及び重ね合わせ測定器（計測装置）をネットワークで通信するためにホストコンピューターを用いて接続したものである。更に、システムを統括制御するホストコンピューターと各露光ユニット（コーター、露光機及びデベロッパーを一組とするライン）の間は、専用のマシンコントローラーMCを設けて露光機、コーター、デベロッパーの各装置の情報を収集できるようにしている。

【００１５】次に、液晶プレート基板の露光工程の通常の流れを説明する。まず、コーターにてレジスト塗布された１ロット分（通常、１０～３０枚）のプレートは露光機に搬送され、露光機にて１ロット全てのプレートが露光される。露光が終了すると、その１ロット分のプレートは速やかにデベロッパーへ搬送され現像が行われる。現像が終了した１ロット分のプレートは、特に重ね合わせの精度が厳しくないレイヤーでは、直ちにエッチング工程へと移され、次のレイヤーの露光工程へと流れていく。

【００１６】ところが、重ね合わせ精度を厳しく管理しなくてはならないレイヤーでは、現像後、プレートはロット毎に重ね合わせ測定器へと移され、そこで重ね合わせ計測を行うことになる。重ね合わせ計測終了後、計測結果である重ね合わせ精度が規格を満足していれば、上述したようにエッチング工程および次レイヤーへと移されていくことになる。しかし、もしも、重ね精度が規格を満足していない場合は、その原因を究明しなければならない。

【００１７】ここで重ね合わせ精度を満足しない原因が露光機にあった場合には、露光機に重ね合わせの補正値を入力することによって対処できる。重ね合わせの補正値は、重ね合わせ測定器による計測結果から算出されるもので、従って露光機の補正値を算出できるような計測ポイントに対して重ね合わせ計測を行っておけばよいことになる。ところで、図２で構成されたインラインでは、各装置の処理時間をある程度調整して、ラインとしてのタクトをできる限り上げるようにしているのが通常である。例えば、コーターまたはデベロッパーの１ロットあたりの処理時間が露光機の処理時間よりも断然に早い場合は、露光機の処理が終了する前に前後の装置の処理が終了してしまうため、そこにラインタクトとしてのロスが発生してしまうことになる。同様に重ね合わせ測定器における１ロットあたりの計測時間も、そのラインタクトに見合うようにしなければならない。重ね合わせ計測器の計測時間は、重ね合わせの計測ポイント数または計測プレート枚数に依存するものである。

【００１８】さて、液晶用ステッパーでは露光領域やプレートサイズの制限から画面の分割を行うのが通常である。また生産性を上げるため、プレート１枚あたりに複数枚のパネルを露光することがある。このようなプレートあたりのパネルの面取りと分割例を図３に示す（図示例では、一つのプレート１０にパネル１１を４面取りし、各パネル１１を４分割した。また、図中、Ａ，Ｂ，Ｃ，Ｄは分割露光の各パターンを示す）。昨今、パネルメーカーでは生産性向上のために、液晶用露光機で１枚のプレートに露光するパネル数は増えてきている。更にステッパーにおいてはスループット向上のために、露光ショット数はできるだけ少なくした方がよい。これらの理由により、ステッパーでは複数枚のレチクルを利用してできるだけ大きなショットで露光を行い、１枚のプレートから多くのパネルを作成することが行われている。これらのことを踏まえて以下、本実施形態の検査方法を述べていく。

【００１９】液晶用露光機においては、重ね合わせ精度を良くするために、重ね合わせの種々の補正値を算出し、その補正値を装置側に入力することが考えられる。本実施形態では液晶用露光機として主として使用されているステッパーを例に説明しており、上記の補正値には、大きく分けてレチクルオフセットと、プレートオフセットとが存在する。レチクルオフセット（レンズ系のオフセットも含む）には、レチクル・シフト（ｘ，ｙ），レチクル・ローテーション，倍率があり、またプレート・オフセットには、プレート・シフト（ｘ，ｙ），プレート・ローテーション，スケーリング（ｘ，ｙ），ステージの配列直交度がある。さて、一例として、図３のようなプレート上の分割と面取りに対する最適な重ね合わせ計測ポイントとしては、図４のような計測ポイント（図中、記号×で表示する）を取るのが望ま

しい。この図４のように重ね合わせを計測すれば、上で述べたレチクル及びプレートの補正値算出には十分である。

【００２０】ところで、図４では１つのショットの４隅（１つの辺で２ヶ所）の重ね合わせを計測しているが、これは最低条件であって、１つのショットに対して１辺を３点以上計測すれば、更に精度のよい重ね合わせ補正値が算出できる事になる。また、重ね合わせ計測を行うプレートの計測枚数であるが、これも多ければ多いほど測定器の計測誤差は低減され、精度のよい重ね合わせ補正値を算出することができることになる。ところが上述したとおり、昨今のフォトリソグラフィーの工程はインラインで構成される場合が多く、ライン全体のタクトを管理するために重ね合わせ測定器における計測時間や計測するプレート枚数はある程度限定されている。

【００２１】そこで、重ね合わせの補正値を露光機へ入力する際に、図４の計測ポイントから算出した方法による補正値と同レベルの精度で重ね合わせの補正を行えるレチクル（マスク）およびプレート（基板）の補正値を、段階的に求めていく本実施形態の方法を図１のフローチャートに従って説明する。

【００２２】デベロッパーにて現像処理された後のプレートは、ロット毎に重ね合わせ検査装置へと搬入され、重ね合わせ計測が行われる（ステップ１）。ここでの計測は、重ね合わせ精度が確認できる程度の簡易なものでよい。重ね合わせ計測終了後、計測結果である重ね合わせ精度が所定の精度を満たしているかが判別される（ステップ２）。満たしていれば、重ね合わせ検査工程を終了し（ステップ８）、次の工程へと移る。一方、重ね合わせ精度が満たされていない場合には、重ね合わせ精度を正確に計測して重ね合わせ精度を補正する検査工程（ステップ３以降）に進む。

【００２３】第１段階の検査（ステップ３）として、図５のような計測ポイントで、まずプレートの補正値を算出する。上記計測ポイントで複数枚のプレートを計測すれば精度は上がる。この際に重要なのは各計測ポイントはショットの中心であること、全てのレチクルにおいての中心を計測すること、更に１枚のプレート内で同一レチクルの複数ショットを計測する場合はなるべく長いパターンにおいて計測することである。図５のように各ショットの中心で重ね合わせを計測すれば、レンズディストーションの影響やレチクルローテーション，倍率などの要因から発生する誤差成分を抑え、プレート側のみの補正値に近い値を算出できる（ステップ３１）。この方法で、プレートシフト（ｘ，ｙ），プレートローテーション，プレートスケーリング（ｘ，ｙ），プレートが載置されるステージの直交度の補正値が求められる。これら補正値が所定の許容値以下にあるか、即ち所定の重ね合わせ精度を満足しているか否かが判別され（ステップ３２）、満足している場合には検査工程は終了し（ステップ８）、満足していない場合には、算出された補正値（プレート成分）に基づいて露光機のプレート側のアライメント補正を行う（ステップ４）。尚、図５では、プレート１０内の４面のパネル１１における４分割の全てのショット中心に対して重ね合わせ計測を行っているが、これでもラインタクトの関係で計測点が多すぎると言う場合は、計測精度は低下するが、同一ショットの重ね合わせ計測ポイント数を減らしても良い。

【００２４】次に、第２段階の検査（ステップ５）に移行するが、その前に第１段階の検査後に行われた重ね合わせのアライメント補正（ステップ４）によりプレート側の誤差成分が安定して取り除けた状態で、第２段階の重ね合わせ補正を行うことが望ましい。

【００２５】第２段階の計測（ステップ５１）の計測ポイント例を図６に示す。ここではレチクル・レンズ側の補正を行うことを目的としている。図６の計測ポイントは露光機の重ね合わせ補正値のレチクル，レンズ成分およびプレートの残留成分を算出するためのものである。一枚のプレート１０中の同一レチクルによるショットは１パネル（図の左上のパネル１１）分だけであるが、そのショット内の計測ポイントは最低４隅としている。もちろん、計測時間に余裕があれば４隅のみならず、１ショット中の各辺において更に計測ポイント数を増やしても良いが、要点は１ショット内の測定ポイント間をできるだけ大きなスパンで計測することである。上記４隅の計測により、各ショットにおけるレチクル・レンズ側の重ね合わせの補正値が算出できる。次に、算出された補正値が所定の重ね合わせ精度を満足しているか否かが判別され（ステップ５２）、満足している場合には検査工程は終了し（ステップ８）、満足していない場合には、算出された補正値（オフセット）に基づいて露光機のレチクル・レンズ側のアライメント補正を行う（ステップ６）。このアライメント補正によって、ステッパーのレチクルシフト（ｘ，ｙ），レチクルローテーション，倍率が補正できる。

【００２６】更に、図６ではショットＡの中心の重ね合わせを計測しているが、これは第１段階の検査工程において補正を行ったプレート成分の残留分を更に補正するためのものである。なぜなら、第１段階で全体的なプレート成分の重ね合わせ補正を行ったとしても、プレート毎のバラツキを考慮すると各ポイント全てにおいて誤差をゼロに追い込むことはできず、またそれに伴ってレチクルオフセットも変化してしまうからである。図６のようなポイントで重ね合わせ計測を行うプレートを複数枚にて計測すれば、重ね合わせ補正の精度を更に上げることができる。一方、ラインタクトの関係で図６の計測ポイントでもポイント数が多いという場合は、あるショット（ここではＡショット）の中心の計測ポイント数を減らすという方法もある。

【００２７】第３段階の検査（ステップ７）として、図

７のような計測ポイントにて重ね合わせ計測を行い装置の状態をモニターする。尚、上記第１，第２段階で重ね合わせ精度を追い込もうとしているレイヤーにおいては、安定して重ね合わせ精度を追い込むことができたことを想定している。

【００２８】図７のようにプレート１０内の同一のショット（ここではAショット）にて複数パネル１１を計測する（ステップ７１）。この際、１ショットあたりの計測ポイントは、４隅と中心１点を最低限、計測するものとする。ここでは第１，第２段階の計測ポイントの考え方と同様に、複数点をできるだけ長いスパンで計測することが望ましい。即ち、あるパネル分の例えばAショットについての計測ならば、そのAショット内の４隅の計測ポイントはなるべく長いスパンで計測する。また中心の計測ポイントは異なるパネルのそれぞれのAショットの中心を計測するが、そのパネル間のスパンはできるだけ長い方が望ましいという事である。

【００２９】このように図７のような計測ポイントにて重ね合わせ計測をロット毎、またはある期間毎に行っていくと特定のレチクルに限定はしているものの、重ね合わせという観点では装置の状態を簡易的に知ることができる。ステップ７２において、重ね合わせ精度が良好ならば、重ね合わせ検査工程は終了し（ステップ８）、もしも未だ不良のときには、再びステップ３の第１段階の検査工程に戻されることになる。

【００３０】以上のように、インラインのタクトの関係で重ね合わせ計測ポイント数にある制限がある場合、段階的に重ね合わせ補正を行う方法を述べてきたが、この実施形態では第１，第２，第３の全ての段階において、計測ポイント数のみならず、計測するプレート枚数においても自由に設定できる。設定に当たっては、インラインのタクトと各段階の１プレートあたりの重ね合わせ計測ポイント数および必要とされる計測精度から決定すればよい。

【００３１】なお、本実施形態では、１プレートにおいてパネル４面取り、１パネル４分割の例を述べたが、本発明はこれら面取り数や分割数に限定されるものではない。例えば１プレートから取れるパネル数を４面取り以外であっても、また、１パネル内の分割数が４分割以外であっても、重ね合わせ計測ポイント数に制限があった場合には段階的に補正を行っていくことで、より正確な重ね合わせ補正をラインタクトを遅らせることなく行うことができる。更に、本実施形態では、露光機としてステッパーについての方法を述べてきたが、本発明はこれに限らずラインの中で使用されるいかなる露光機についても適応できる。

【００３２】

【発明の効果】上述のように本発明によれば、重ね合わせ計測を、基板側の重ね合わせ精度を検出するための計測とマスク又はレチクル・投影光学系側の重ね合わせ精度を検出するための計測とに分けて段階的に検査しているため、一回の計測ポイント数が減少し、計測時間を短縮できる。しかも、基板側及びマスク又はレチクル・投影光学系側の誤差成分を算出できる適正な計測ポイントに対して段階的に重ね合わせ状態の計測を行うので、正確な重ね合わせ精度を算出でき、重ね合わせ精度を確実に追い込むことができる。従って、インラインで構成されているフォトリソグラフィー工程に適用すれば、全体のラインタクトを遅らせることなく露光装置の重ね合わせ精度を正確に追い込める。

【図面の簡単な説明】

【図１】本発明の重ね合わせ検査方法の一実施形態を示すフローチャートである。

【図２】本発明の重ね合わせ検査方法を適用する、フォトリソグラフィー工程のプロセス管理システムの一例を示す構成図である。

【図３】本発明の実施形態において露光機により露光される、１プレート内のパネルの面取りと各パネルの分割を示す図である。

【図４】図３の露光に対して行われる適正な重ね合わせ計測ポイントの例を示す図である。

【図５】本発明の実施形態における第１段階の重ね合わせ計測の計測ポイントを示す図である。

【図６】本発明の実施形態における第２段階の重ね合わせ計測の計測ポイントを示す図である。

【図７】本発明の実施形態における、重ね合わせ状態を知るための第３段階の重ね合わせ計測の計測ポイントを示す図である。

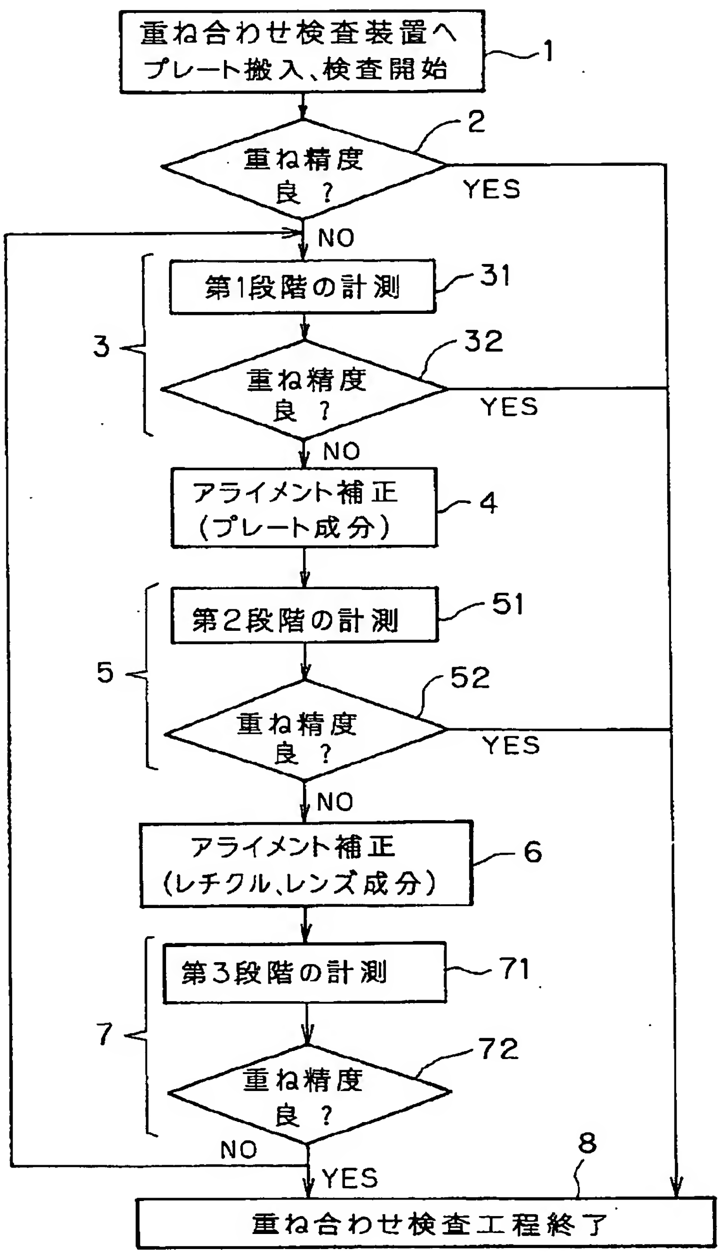
【符号の説明】

１０　プレート（基板）

１１　パネル

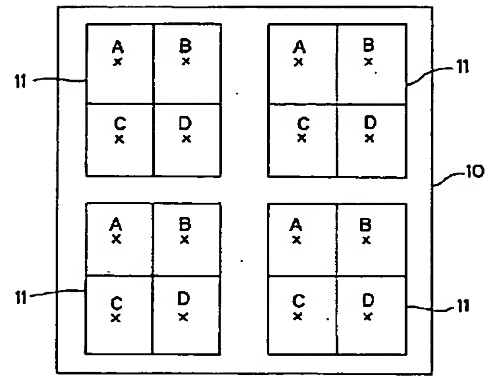
MC　マシンコントローラー

【図１】



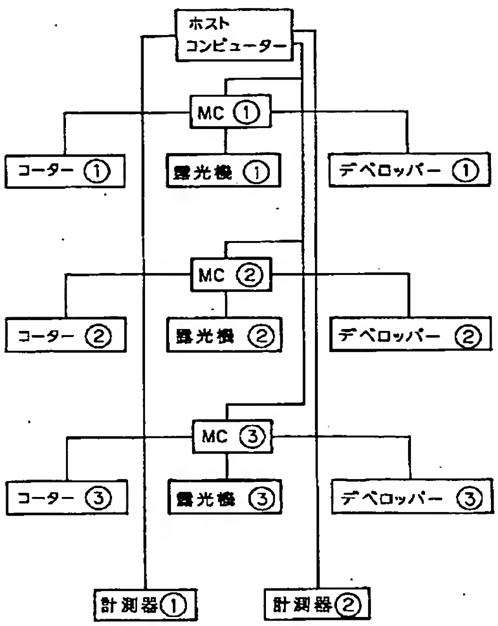
重ね合わせ検査装置へ
プレート搬入、検査開始
1
2
重ね精度
良 ？
YES
NO
第1段階の計測
31
3
32
重ね精度
良 ？
YES
NO
アライメント補正
（プレート成分）
4
第2段階の計測
51
5
52
重ね精度
良 ？
YES
NO
アライメント補正
（レチクル、レンズ成分）
6
第３段階の計測
71
7
72
重ね精度
良 ？
NO
YES
8
重ね合わせ検査工程終了

【図５】

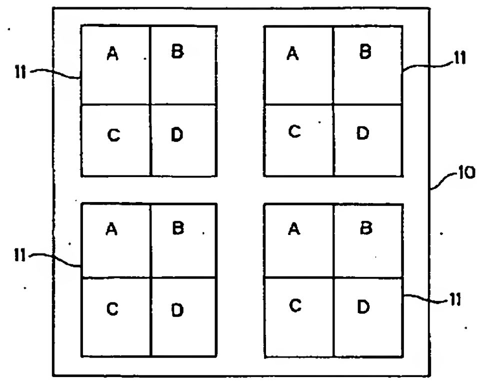


A
B
C
D
11
10

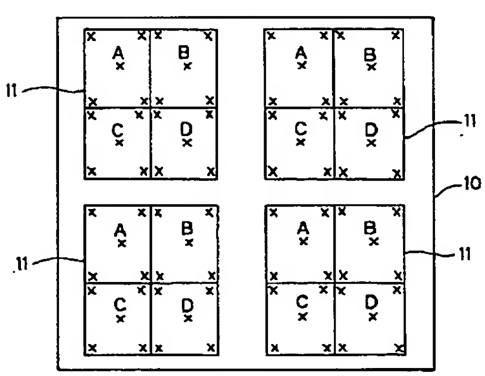
【図２】


ホスト
コンピューター
MC ①
コーター ①
露光機 ①
デベロッパー ①
MC ②
コーター ②
露光機 ②
デベロッパー ②
MC ③
コーター ③
露光機 ③
デベロッパー ③
計測器①
計測器②

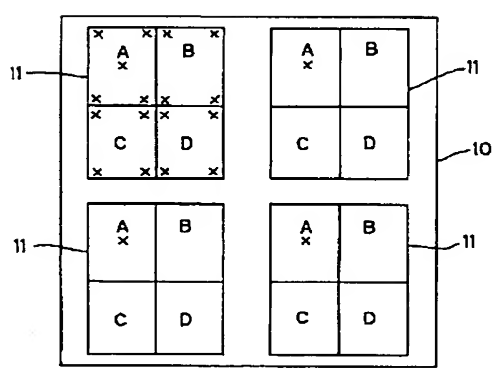
【図３】


A
B
C
D
11
10

【図４】


A
B
C
D
11
10

【図６】


A
B
C
D
11
10

【図７】